Replacement of fish meal with maggot meal in African catfish (*Clarias gariepinus*) diets

Sustitución de harina de pescado con harina de larvas en dietas para el bagre Africano (*Clarias gariepinus*)

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ABSTRACT

Maggot meal produced from maggots grown on a mixture of cattle blood and wheat bran was used in substituting fish meal in African catfish, *Clarias gariepinus,* diet. A feeding trial was carried out for a period of ten weeks to evaluate the growth and nutrient utilization of catfish juveniles using diets in which fish meal was substituted with maggot meal at the following levels, 0, 50, and 100 %. Proximate and amino acid analyses of the maggot meal were carried out. Also the proximate composition of the test diets was determined. The results showed that maggot meal has 92.7% dry matter, 47.6% crude protein, 25.3% fat, 7.5% crude fiber, 6.25% ash, and an amino acid profile comparable to fish meal. Maggot meal-based diets compared favourably with fish meal-based diets as there were no significant differences in the growth and nutrient utilization indices (weight gain, length gain, daily growth rate, specific growth rate, feed conversion ratio and protein efficiency ratio). It is concluded that maggot meal is a viable alternative protein source to fish meal in the diet of African catfish. Its utilization is expected to reduce feed cost drastically, thus leading to a viable and sustainable aquaculture industry.

Kew words: Maggot meal, *Clarias gariepinus,* fish meal replacement

RESUMEN

Se utilizó harina de larvas producida a partir de larvas cultivadas en una mezcla de sangre de ganado y afrecho de trigo en la sustitución de la harina de pescado en dietas pare el bagre Africano (*Clarias gariepinus*). Se realizó un ensayo de alimentación para investigar el eefcto de la harina de larvas sobre el crecimiento y la utilziación de alimento. Se formularon tres dietas las cuales contenían diferentes concentraciones de harina de larvas como sustituto de la harina de pescado (0, 50 y 100% nivel de sustitución). Después de un periodo de diez semanas, las dietas basadas en harina de larvas se compararon favorablemente con las dietas basadas en harina de pescado debido a que no hubo diferencias significativas en el crecimiento y los índices de utilización del alimento (ganancia de peso, incremento de longitud, tasa de crecimiento específica, relación de conversión de alimento y relación de eficiencia proteica). Se concluye que la harina de larvas es una fuente de proteínas viable y alternativa a la harina de pescado en la dieta del bagre Africano. Se espera que su utilización reduzca drásticamente el costo de alimentación, lo que conduciría a una industria acuicola viable y sustentable.

Palabras clave: Harina de larvas, *Clarias gariepinus,* sustitución de harina de pescado.

INTRODUCTION

Feed is the single most expensive factor in aquaculture production and the protein component of fish diet constitutes the highest cost. The proportion of protein in fish diets is higher than those of other cultured animals, thus making feeds very exorbitant. Studies have shown that the African catfish, *Clarias gariepinus,* requires about 40% crude protein in their diet and best results have been achieved with crude protein values ranging from 35-50% for all African catfish species (Wilson and Moreau 1996; Adebayo and Quadri, 2005).

In Nigeria, the bulk of the feed used in fish production, especially for catfishes, is imported and this has led to a high production cost of farmed fish. Aquafeed production in most African countries is yet to be commercialized due to the ever-rising cost of feed ingredients, especially fish meal which is imported. The rising cost of diet ingredients, especially fish meal, has thus retarded the growth of aquaculture in Africa. With the ever increasing demand for fish meal globally, it is expected that its cost will continue to rise in the world market. In order to stem this trend, scientists are carrying out studies to identify cheaper alternatives with comparable nutritional quality. Maggot meal has been reported to be a possible alternative (Sheppard 2002; Teguia *et al.* 2002; Ogunji *et al*. 2006).

It has good nutritional value, cheaper and less tedious to produce than other animal protein sources. It is also produced from wastes, which otherwise would constitute environmental nuisance. The production system thus serves the dual purpose of providing a nutrient-rich resource as well as a source of waste transformation and reduction. However, the production system is yet to be commercialized (Teguia 2005) probably because its utility and value in aquafeeds have not been elucidated. The reported crude protein values range from 43 to 62 % (Awoniyi *et al,* 2003; Fasakin *et al*. 2003). As far as we know, there is a dearth of information on the utilization of maggot meal in aquafeeds.

The few studies on its utilization in replacing fish meal in fish diets are inconclusive, especially with particular reference to catfishes. This research is therefore, aimed at evaluating for the first time, the substitution of fish meal with maggot meal from a commercial model, in catfish diets. It is believed that this study would provide the springboard for commercialization of maggot meal production process and thus provide an inexpensive animal protein source for aquafeeds.

MATERIALS AND METHODS

Maggot production and experimental diets

One hundred kilogram of cattle blood and 20 kg wheat bran were mixed together and spread on a floor space of 6m^2 to a thickness of 3 cm to constitute the substrate. The odor of fresh blood and subsequently, fermenting substrate attracted flies, which later laid eggs on it. The eggs hatched into larvae within two days and were allowed 48 hours to develop further. The mature maggots were harvested, sun dried until a constant weight was achieved. The dried maggots were milled into a meal using a hammer mill.

Proximate composition of the maggot meal (Table 1) was determined using the method described in AOAC (1990). Also, amino acid analysis of the maggot meal was carried out using Technicon Sequential Multi sample amino acid analyzer (TSM) as described in AOAC (1990).

Three isonitrogenous and isocaloric diets (D) were formulated (Table 2) as follows: DI was a fish meal-based diet (containing 25% fish meal), while D2 was a maggot meal substituted diet (containing 12.5% each of fish and maggot meals), and D3, a maggot meal-based diet (containing 25% maggot). Other ingredients used in the formulation included maize, soya bean meal, blood meal, wheat bran, palm oil, bone meal, vitamin and mineral premix and methionine. This formulation is in conformity with the nutritional requirement of the species as given by Uys (1989). The diets were pelleted using motorized pelleter of 2mm die size. The pellets were subsequently sun-dried. Samples of the three diets were subjected to proximate analysis (AOAC 1990) (Table 2).

Feeding Trial

One hundred and thirty-five catfish juveniles of the same age and uniform size were procured. The fish having an average weight of 10g were divided into three groups of 45 fingerlings each, and each group assigned to a dietary treatment. Each treatment had three replicates, and the fish from each replicate were held in a 1 x 0.5 x 1.2 m concrete tank at a stocking rate of 15 fish/ tank. The fish were fed daily at 5% of their body weight for a period of ten weeks. This feeding rate is adjudged suitable for African catfishes of comparable life history stage as the one used in the present study (Erondu *et al*., 2006; Sogbesan *et al*., 2006). Each fish was weighed and total length measured using Ohaus Scouth II digital top loading balance and meter rule, respectively, on a weekly basis.

Table 1. Proximate composition of housefly maggot meal generated from a mixture of cattle blood and wheat bran on dry-matter basis.

Nutrient	Composition (%)
Dry matter	72.7
Crude protein	47.6
Fat	25.3
Crude fiber	7.5
Ash	6.25

From the data, the following growth and nutrient utilization parameters were computed: weight gain, length increase, daily and specific growth rates, feed conversion ratio and protein efficiency ratio.

All the data collected were subjected to Analysis of Variance, using the SAS general linear model, to determine any differences in means among the dietary treatments.

RESULTS

Proximate composition of housefly maggot meal is shown in Table 1, while Table 3 is a presentation of its amino acid profile. The values recorded indicate that the biomaterial has a good nutrient quality, especially when compared with fish meal (Table 3).

Table 2. Formulation and nutritional composition of experimental diets.

	Diets (%)		
Ingredients	D1	D2	D3
Corn	11	11	11
Soy bean meal	34	39	43.5
Fish meal	25	12.5	-
Maggot meal (HFLM)	-	12.5	25
Blood meal	10.3	10	10
Wheat bran	11	8.0	6.0
Palm oil	5.2	3.5	1.0
Bone meal	3.0	3.0	3.0
Vitamin/Mineral premix*	0.3	0.3	0.35
DL-Methionine	0.2	0.2	0.15
Total	100	100	100
Nutritional composition (in % of dry matter)			
Dry matter	90.45	90.78	90.13
Crude Protein	40.76	40.59	40.74
Ether extract	9.2	8.98	8.51
Crude fiber	4.1	4.87	5.22
Ash	10.59	9.10	8.0
M.E (kcal/kg)	2,795.8	2,794.5	2,737.3
M.E.(MJ/kg)	11.7	11.69	11.45

* Biomix fish vitamin/mineral premix providing per kg of diet at 5kg per tonne inclusion: 20,000 i.u, Vitamin A, 2000 i.u,Vit. D3, 200 mg Vit E, 8mg Vit K3, 20mg Vit B1, 30mg Vit B2, 12mg Vit B6, 50 mg Pantothenic acid, 0.8mg Biotin, 150 mg Niacin, 0.05mg Vit B12, 4.0mg Folic acid, 500mg Vit C, 600 mg Choline chloride, 200mg Inositol, 200mg Betaine, 2.0mg Cobalt, 40mg Iron, 5.0mg lodine, 30mg Manganese, 4mg Copper, 40mg Zinc, 0.2mg Selenium, 100mg Lysine, 100mg Methionine, 100mg Anti-oxidant.

There were no significant differences ($p>0.05$) in all the parameters measured in this study (Table 4).

Fish Growth

The values recorded for the growth parameters evaluated are presented in Table 4. Diet 1 recorded an average weight gain of 248.61g and length increase of 22.71cm; D2 weight and length gains of 259.02 g and 22.94 cm; while D3 recorded 263.98g and 23.53cm weight and length gains, respectively. The average DGR values were 0.44g, 0.46g and 0.47g for D1, D2 and D3, respectively while SGR values were 2.53, 2.55 and 2.56 for D1, D2 and D3, respectively. These values were not significantly different ($p>0.05$) (Table 4).

Nutrient Utilization

The FCR values were 1.15, 1.17 and 1.16 for D1, D 2 and D3, respectively; while PER for D1 was 2.55; 2.60 for D2 and 2.60 for D3. The differences were not statistically significant (Table 4).

Table 3. Amino acid profile of housefly maggot meal compared with that of fish meal

Amino acid	Housefly maggot meal	Fish meal*
Histidine	3.09	1.36
Arginin	5.80	3.99
Aspartic acid	8.25	Not given
Threonine	2.03	2.60
Serine	3.23	Not given
Glutamic acid	15.3	Not given
Proline	2.85	Not given
Glycine	4.11	Not given
Alanine	2.86	Not given
Cystine	0.52	0.82
Valine	3.61	3.09
Isoleucine	3.06	2.97
Leucine	6.35	4.45
Lysine	6.04	4.55
Tyrosine	2.91	1.98
Phenylalanine	3.96	2.35
Methionine	2.28	1.68
Tryptophan	-	0.69

*N.R.C. (1977)

DISCUSSION

The non significant differences of the evaluated growth and nutrient utilization indices among the three treatments imply that maggot meal can successfully replace the entire fishmeal portion of the fish diet. Other authors have observed a better performance of fish fed diets containing maggot meal over those solely fed on fish meal diets (Ogunji *et al*., 2006). This is a reflection of the nutritive quality and acceptance of this biomaterial.. The result also corroborates previous observation that maggot meal, like other animal protein sources was well accepted and utilised by fish (Alegbeleye *et al.* 1991; Idowu *et al.* 2003).

It has been suggested that the good growth and nutrient utilization capacity of fish fed maggot-based diets stem from the high biological value ie nutrient composition and digestibility, of the ingredient (Sogbesan *et al*., 2006). Jhingram (1983) reported that maggots are easily digested by fish and this has been attributed to its relatively high crude fibre content, which according to Fagbenro and Arowosoge (1991) plays a significant role in feed digestion. The non significant difference in the values of FCR of the treatment diets is possibly indicative that both protein sources compared favourably in feed to flesh conversion. It has been reported that the biological value of maggot meal is equivalent to that of whole fish meal (Ajani *et al*., 2004). This fact is strengthened by the results obtained in the present study.

The PER values were good and not significantly different, and this is consistent with the results reported by Atteh and Ologbenla (1993) that amino acid profile of maggot meal is similar to that of fish meal and meat meal, with a positive linear effect on the fish body protein (Adebayo and Quadri 2005). Sheppard and Newton (1999) have also reported that maggot oil is high in desirable medium chain and mono unsaturated fatty acids, and rich in phosphorus, trace elements and B-complex vitamins (Teotia and Miller, 2003). Ogunji *et al*. (2006) postulated that several other ingredients of animal origin such as feather meal, poultry by-product meal, and also plant protein sources may not successfully replace fish meal in aquafeeds due to their inferior amino acid profile, and nutrient inhibition factors found in the latter class. Utilization of maggot meal will thus pave way for cheaper and nutritionally rich aquafeeds.

CONCLUSIONS

It is concluded that based on production cost, availability, biological value, growth and nutrient utilization, maggot meal is a viable alternative protein source to fish meal in catfish diets. This is especially so in developing countries like Nigeria where fish meal is imported at an exorbitant cost. Though there may be slight constraints in commercial production of maggot meal presently, these can be overcome through active and well-directed research. Aquaculture industry can thus benefit from wide availability of local and inexpensive aquafeeds. This is the key to the development of a productive and sustainable aquaculture in developing countries.

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Table 4. Growth and nutrient utilization data of *Clarias gariepinus* juveniles fed on maggot meal substituted diets *.

	Diets		
Production parameters	1 (0%)	2 (12,5%)	3 (25%)
Initial weight (g)	10.0±0.0	10.02±0.025	10.0±0.02
Initial length (cm)	8.32±0.009	8.41±0.7	8.36±0.02
Final body weight (g)	258.61±0.15	269.04±19.07	273.98±20.24
Weight gain (g)	248.61±0.10	259.02±24.05	263.98±27.39
Length increase (cm)	22.71±0.54	22.94±0.087	23.53±0.09
Specific growth rate	2.53±0.09	2.55±0.07	2.56±0.07
Feed conversion ratio	1.15±0.10	1.17±0.095	1.16±0.10
Protein efficiency ratio	2.55±0.53	2.60±0.52	2.60±0.56

* The values of the indices among the different treatments were not significantly different (p>0.05)

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